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ABSTRACT

This study investigated the comparative capacity of women-only and co-educational colleges to impact on two dimensions of women students' intellectual development: (1) intellectual self-confidence; and (2) critical thinking and problem-solving skills. The study also attempted to isolate the effect of attending women-only colleges from other potentially confounding individual- and institutional-level predictors (e.g., degree aspiration, father's education, minority group status) using a multi-level model technique. Data were from the Cooperative Institutional Research Program (CIRP) and the Higher Education Research Institute. The subset of CIRP data included 2,472 female freshmen attending private four-year colleges in the United States who were surveyed during their freshman and senior years. Data from faculty at 392 colleges and universities focused on faculty characteristics and interaction with students. It was concluded that attending a women-only college did have an effect on intellectual self-confidence but did not make a big difference with regard to self-reported growth in critical thinking and problem-solving skills when the effect of attending a black college was controlled. Seven tables contain statistical data supporting the conclusions. Two appendices contain lists of individual- and institutional level-predictor variables. (Contains 41 references.) (CK)

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The Effectiveness of Women-Only Colleges for Intellectual Development of Women Students

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One of the most salient characteristics by which modern societies are differentiated from their traditional origins is the increasing number, variety, importance, and power associated with roles women are expected to take on. The societal expectation is that, at graduation, regardless of the nature of their education, college women will assume societal roles generally and occupational roles in particular on an equal footing with their male counterparts. In light of this trend, a major social expectation is that institutions of higher education will develop women students who are not only intellectually capable, but also self-confident about their capabilities. Cumulative research shows that attending a specific type of college can differentially affect cognitive learning ability among various student populations (Astin, 1977, 1993; Bowen, 1988; Feldman and Newcomb, 1973; Pascarella, 1984; Pascarella and Terenzini, 1991; Terenzini and Wright, 1987).

Evolving societal notions of propriety have varying effects on different kinds of educational institutions. During the last three decades, the ever more prominent call for gender equality has increasingly undermined the social legitimacy of women-only colleges. The vast majority of them have either closed or transformed themselves into coeducational institutions. Currently, only 84 (71 four-year, 13 two-year) women-only colleges remain in operation in the United States (Women's College Coalition, 1992). Decisions producing these transformations appear to have been driven by social and economic pressure rather than by any sound theory of education (Kim and Alvarez, 1995). Nor have these decisions been made by reference to empirical research evidence resulting from systematic comparison of educational efficacy by women-only and coeducational institutions. On the presumption that public policy makers will eventually turn to the research community for evaluation of social and economic demands, it is

critical to continue cumulating systematic empirical evidence on the effectiveness of women-only colleges in promoting the intellectual development of women students and the possible reasons for their apparent advantage over coeducational institutions.

Most studies of women-only institutions have focused on *post-college* career achievements and retrospectively inferred levels of intellectual development during college years (Tidball, 1973, 1980, 1985, 1986; Oates and Williamson, 1978; Rice and Hemmings, 1988; Stoecker and Pascarella, 1991). Tidball (1973) notes that graduating from a women's college positively affects women's career success, as measured by the proportion of achievers listed in Who's Who of American Women (WWAW) for the decades 1910-1960. Oates and Williamson (1978), using Who's Who in America (WWA), 38th Edition, 1974-1975, found graduates from women-only colleges were still listed more often (1.9 times) than women graduates from coeducational institutions. Subsequently, Tidball also reports that graduates of women's colleges were more than twice as likely to have received research doctorates as were women graduates of coeducational institutions (1980). She found a similar pattern for female entry into medical schools, women from women-only colleges having a higher rate of entry (1985). She also reports that women-only colleges constitute the undergraduate base from which come the highest proportion of female doctoral scientists (1986).

Relatively few studies have investigated the impact of women-only colleges on students' intellectual or academic development *during* college (Astin, 1977, 1993; Smith, 1990; Kim and Alvarez, 1995). Astin (1993) states that women's colleges have a positive impact on a student's self-reported growth in overall academic development, cultural awareness, analytical problem-solving skills, critical-thinking abilities, writing skills, and foreign-language skills. Riodan (1994) revealed that women who attended a women's college for one year were significantly

more likely to achieve higher levels of education than those who had never attended. Consistent with Astin (1977), Smith (1990) found differences in measures of student satisfaction as well as in students' perception of institutional goals. Students at women's colleges evaluate their academic program more strongly than their counterparts at coeducational institutions evaluate theirs. Also, students at women-only colleges rate their institutions higher on "conveying an appreciation of the liberal arts, increasing self-directed learning, developing clear thinking, developing creative capacities, gaining a deeper level of understanding..." (Smith, 1990, p. 191). After controlling for pertinent input variables, Kim and Alvarez (1995) found that women's colleges have an advantageous effect on students' academic ability and improve students' social self-confidence by providing better opportunities both to be actively involved in student organizations as well as to exercise leadership in them.

Pioneering studies by Tidball and the subsequent genre of studies she instigated have been challenged for not controlling important pre-collegiate characteristics and family socioeconomic status (Rossi, 1987; Stoecker and Pascarella, 1991; Kim and Alvarez, 1995). For example, Tidball's assertion that the higher ratio of female faculty in women's colleges may account for the effectiveness of women's colleges in producing a high proportion of women achievers has not been supported by others. Kim and Alvarez (1995) and Kim (1995) present evidence that the high ratio of female faculty in women-only colleges is not a direct positive factor accounting for higher achievement by graduates of women's colleges. Thus, Tidball's previously proposed explanations of why women-only colleges seem to have better outcomes than coeducational institutions turn out to be implausible.

Moreover, I have found no reference in the literature to any previous study taking into account the racial composition of the student body. Evidence from Fleming (1982, 1984)

suggests that colleges with predominantly black student populations promote greater growth in cognitive development between freshman and senior years than do predominantly white institutions. Pascarella and Terenzini, summarizing data from studies of black colleges, state that "attending a predominantly black college had a significant and positive indirect effect on the academic and social self-concepts of black female students" (1991, p. 185). Thus, because previous studies of women-only colleges did not control for "black college status" (even when their samples included black colleges), results reported by those studies may have inadvertently contained an unexplored confounding effect.

The present study seeks to employ more rigorous methodologies and to fill gaps in the evidentiary record, while expanding the range of criteria by which to evaluate effectiveness of women-only colleges. This study also seeks to enhance the level of methodological rigor characteristic of research on women-only colleges. The focus of this paper is the comparative capacity of women-only and coeducational colleges to impact on two dimensions of women student's intellectual development: (1) intellectual self-confidence and (2) critical thinking and problem-solving skills. Intellectual self-confidence provides a good sense of students' overall intellectual development and a potential for intellectual growth. Critical thinking and problem-solving skills reflect comprehensive intellectual ability and are at the highest level of intellectual development (Perry, 1970). This study attempts to isolate the effect of attending women-only colleges from other potentially confounding individual-level and institution-level predictors (see Appendix A) using a multi-level model technique.

Research Hypotheses

This study is both evaluative and exploratory. The following specific hypotheses were examined for evaluative purposes.

Hypothesis 1. There is no difference in institutional effectiveness between women-only colleges and coeducational institutions in promoting self-reports of intellectual self-confidence.

Hypothesis 2. There is no difference in institutional effectiveness between women-only colleges and coeducational institutions in promoting self-reports of critical thinking and problem-solving skills.

The procedure employed was first to evaluate evidence for or against these hypotheses. Thereafter, data were explored to see if expanded use of the models could provide insights concerning how either type of institution affects women students' intellectual development.

Methodology

The Survey

Two student data sets employed were provided by, respectively, the Cooperative Institutional Research Program (CIRP), which is sponsored by the American Council on Education, and by the Higher Education Research Institute (HERI) at the University of California, Los Angeles. The major purpose of CIRP is to assess the multiple impacts college attendance has on students. Two sources of information on students were used: Student Information Form (administered at freshman year) and College Student Survey (administered at point of graduation).

The faculty data set employed was provided by HERI, which has conducted an annual national survey of college and university faculty since 1989. Respondents were full-time faculty members who taught undergraduates at least part of the time, at 392 two-year and four-year colleges and universities (Astin, Korn, and Dey, 1991). The questionnaire focused on (a) characteristics of faculty members at various institutions, (b) styles of faculty interaction with students, and (c) biographical and demographic information about faculty.

The Sample

This study is limited to responses from women students who attended private four-year colleges in the United States. Public four-year colleges as well as both private and public universities were excluded in order to make the sample of coeducational colleges more comparable to mostly private, small, women-only colleges. The study utilized two sets of data: a large set and a small set. The 1989 faculty survey does not "match" all the institutions from the student survey. To examine the effectiveness of women-only colleges, this study depends mainly on the large data set which unfortunately does not contain information on characteristics of faculty. The small data set was created by matching institutions with faculty respondents to institutions with student respondents. It was used here for supplementary analyses to explore the association between women-only colleges and faculty climate as well as the impact of various faculty climate on students' intellectual development.

The maximum number of usable cases in the large data set consists of 2,472 female freshmen who responded to an initial survey in the fall of 1987 and to the follow-up survey taken during the summer of 1991, after their senior year. Only responses from students who participated in both the initial and follow-up surveys were used: 2,080 were from women in 173 coeducational institutions, and 392 were from students in 28 women's colleges (note that there are only 71 four-year colleges in the United States including two universities). Usable cases in the small data set consisted of 1,397 female students from institutions that matched the institutions of respondents to the faculty survey: 1,059 of the women were from 73 coeducational colleges, and 338 of them were from 13 women-only colleges.

The Variables

Two outcome variables used to examine institutional effects on intellectual development are (1) self-reported intellectual self-confidence and (2) self-reported critical thinking and problem-solving skills (composite question items: the ability to think critically, analytical and problem-solving skills) in the 1991 follow-up survey. Cronbach's alpha (internal consistency of composite items) for critical thinking and problem-solving skills is 0.63.

"Intellectual self-confidence" is operationally defined by responses to the following 1987 and 1991 survey item: "Rate yourself on each of the following traits as compared with the average person your age. We want the most accurate estimate of how you see yourself" (Astin, et al., 1987, p. 110; Higher Education Research Institute, 1992, p. 208). Self-reports were measured on a five-point scale: highest 10%, above average, average, below average, and lowest 10% (Astin, et al., 1987, p. 110; Higher Education Research Institute, 1992, p. 208).

"Critical thinking and problem-solving skills" is operationally defined by responses to the senior-year survey only. Students were asked to respond to the following questionnaire item: "Compared with when you entered college as a freshman, how would you now describe your....? (Mark one for each item.)" Self-reports were measured on a five-point scale: "much stronger," "stronger," "no change," "weaker," and "much weaker" (Higher Education Research Institute, 1992, p. 209).

It is important to adjust for pre-college traits that students bring to college because these are often the major predictors of student characteristics at point of exit from college. Thus, it is important to distinguish that from the institutional impact of the college itself. Students' pre-college characteristics are (a) students' academic preparation (as measured by their high-school grade point average and degree aspiration), (b) parental socioeconomic status (as measured by

parental income and father's education), (c) student's minority status (vs. white), and (d) pre-test (students' initial level of intellectual self-confidence).

Environment variables (individual-level and institution-level) were deliberately selected a) in order to assess the precise effect of attending a women's college and b) to examine why women-only or coeducational institutions are more conducive to female students' intellectual development, if any institutional difference was previously indicated. The two major individual-level environmental variables used were peer orientation (students' association with intellectually esteemed peers, permissive peers, socially active peers, and peers from high socioeconomic status) and college activities (leadership experience, campus work experience, interaction with faculty, participation in diversity awareness programs, and enrollment in honors programs).

Two types of institution-level environmental variables were considered: global college characteristics and internal college characteristics. "Global college characteristics" are defined as college structural characteristics that are extremely difficult to change or manipulate; they are, perhaps, changeable in the long run. "Internal college characteristics" are defined as being relatively changeable and observable during the period students and faculty are normally within the college. Global institution-level variables consist of student body selectivity (as based on Scholastic Aptitude Test composite scores), historically black college status, Catholic college status, institutional location in the east, enrollment size, mean pretest, and women-only college status. Women-only college status is the key independent variable because this study seeks to assess the effectiveness of women-only colleges as compared with coeducational institutions. Historically black college status was taken into account in order to separate out the institution effect of a largely minority population.[1] Catholic college status was included to isolate Catholic college effect. A higher proportion of women-only colleges were Catholic-affiliated (29 % of

women-only colleges in the sample were Catholic-affiliated, whereas 12% of coeducational colleges were Catholic-affiliated).

The internal institution-level variables used were mean institutional peer orientations (i.e., permissive peers and socially active peers), percent of expenditures used for academic and student service, faculty climate (i.e., faculty liberalism, student orientation, diversity orientation, research orientation, social activism and community orientation, female faculty ratio, and student-faculty interaction), and women's/minority studies (the offering of gender studies and/or minority or Third World studies) and a progressive curriculum. Proportions of institutional expenditures devoted to academic and student services were considered in order to explore how institutional priorities affect students' intellectual development. Mean institutional peer orientation and mean faculty climate were used to understand impact of institutional climate. Faculty have been identified as a key intervening factor in predicting student development (Pascarella, 1980; Austin, 1990). The percentage of female faculty at an institution was included because it is currently a controversial point in the literature on student development. See Appendix A for detailed descriptions and the coding scheme of the variables used in this study.

The Analysis

Two separate analytic procedures were used to evaluate hypotheses. The first procedure was to conduct a supplementary analysis through use of cross-tabulation and Wilcoxon matched-pairs signed-rank tests to observe changes in self-rated intellectual self-confidence between freshman and senior years among women-only and coeducational institutions. The second procedure consisted of using hierarchical linear models (HLMs). These models allowed for comparison of effects by institutional type before and after controlling for internal characteristics of college. If significant institutional effects were found, the HLMs were used to

further explore which institutional characteristics might account for these effects. To do so, changes among coefficients, statistical significance levels, and variations were observed. HLM residual files were used to check that underlying statistical assumptions for use of the models (i.e., distribution, outliers, linear relationship) were met. The following section briefly presents the basic logic of the HLM models used for this study.

Overview of Hierarchical Linear Models

For this study, a two-level hierarchical linear model (Bryk and Raudenbush, 1992) was used to analyze nested survey data obtained from CIRP and HERI. A two-level model, within a single analytic framework, allows researchers to investigate hypotheses about the effects of within-college and between-college factors on outcomes of interest. The within-college model examines how differences in individual-level characteristics (e.g., individual students' input characteristics and college activities) relate to individual-level outcomes (e.g., student growth in critical thinking and problem-solving skills). The between-college model examines how college compositional characteristics (e.g., selectivity, women-only college) relate to college mean outcomes (e.g., the mean change in critical thinking and problem-solving skills for the students in a college). The following two equations for the within-college model and for the between-college model are the bases of the HLM analyses for institutional effectiveness.

The basic within-college model is:

$$Y_{ij} = \beta_{0j} + r_{ij}, \qquad r_{ij} \sim N(0, \sigma^2) \qquad (1)$$

where Y_{ij} is the response of student i in college j, β_{0j} is the mean score for college j, and r_{ij} is a random error (i.e., a unique effect associated with person i in college j on the mean outcome of interest) that is normally distributed with mean 0 and variance σ^2. Note that σ^2 represents

within-college variation.

The between-college model is:

$$\beta_{0j} = \gamma_{00} + u_{0j}, \qquad u_{0j} \sim N(0, \tau_{00}) \qquad (2)$$

where β_{0j} is the college mean from the within-college equation, γ_{00} is the grand mean of the outcome of interest (i.e., the overall average for college mean outcome), and u_{0j} is a random error. u_{0j} is a residual that captures the deviation of the mean for college *j* from the grand mean. The residual is normally distributed with mean 0 and variance τ_{00}. In the model, τ_{00} represents the extent to which college mean outcome scores vary around the grand mean outcome score; thus, τ_{00} is a measure of between-college variation. The above equations can be then expanded to include individual- and institution-level predictors.

A hierarchical linear model is like a regression with multiple levels. Its logic and interpretation (e.g., coefficients, standard deviations) are similar to those of standard linear models (e.g., regression and ANCOVA models) except that within-college regression coefficients (β_{nj}) can be allowed to vary randomly across colleges in the analysis of HLMs. Refer to Appendix C for the HLM equation developed to investigate the effectiveness of women-only colleges in students' intellectual development.

Results

Analysis of Cross-tabulation and Wilcoxon Tests

Wilcoxon matched-pair signed-rank tests indicate that, regardless of type of college, women students gained in intellectual self-confidence during their college years ($p < 0.0001$; see Table 1). Wilcoxon tests were used not only because they are useful for a quick grasp of overall

change, but also because students' responses on pre-tests and post-tests are mutually dependent. Cross-tabulation suggests that attendance at either women-only or coeducational colleges matters in the development of intellectual self-confidence. However, cross-tabulation of intellectual self-confidence with type of college reveals that the proportion of students at women-only colleges who reported themselves among the "highest 10%" and "above average" on the pre-test increased by 17.1% on the post-test, while the proportion of female students in coeducational institutions increased only 10.7%.

TABLE 1 ABOUT HERE

Analysis of Hierarchical Linear Models

Intellectual Self-confidence

The two dimensions of intellectual development were analyzed using four models: the student characteristics model (model 1), the women's/coed colleges model (model 2), the full model (model 3), and the supplemental model (model 4). Starting with the most simple model (the student characteristics model) as a foundation, each subsequent model built upon the previous model in a step-up sequence. The two hypotheses were tested by results presented in the women's/coed colleges model, controlling for global college characteristics. I used the full and supplemental models to further explore how internal characteristics of colleges affect outcomes of interest. I also explored how the estimate of the effect of women-only colleges on the outcomes changes when characteristics of internal college environment are taken into account in these models.

Student Characteristics Model. The student characteristics model was used to estimate a) the effects of individual-level predictors on intellectual self-confidence, b) the grand mean outcome, c) the proportion of within-college variation explained by the model, and d) the amount

of initial between-college variation. Table 2 presents the student characteristics model as the basis upon which subsequent models are built.

Predictors in the model consist of four input characteristics (ethnic minority status, high school GPA, father's level of education, and intellectual self-confidence upon entry to the college) and four environment variables (being around intellectually esteemed peers, interaction with faculty, participation in diversity awareness programs, and participation in honors programs). In the model, student-level predictors explain 20.9% of the total within-college variance in intellectual self-confidence at the end of students' senior year.

Not surprisingly, students' initial intellectual self-confidence and contact with intellectually esteemed peers were highly significant (for pretest, b=0.215, t=8.222; for peer intellectual self-esteem, b=0.057, t=8.193). Other important positive predictors were identification as an ethnic minority, interaction with faculty, participation in diversity awareness programs, and participation in an honors program. Participation in an honors program may be considered a reflection of a high college GPA or high academic achievement.

High school GPA and father's level of education were included in the model for theoretical reasons[3] in spite of their statistically insignificant contribution. Both variables were highly significant ($p < 0.01$) in the equation that included only student input variables, but their coefficients faded to insignificance (because these variables share predictivity for the outcome of intellectual self-confidence) when environment variables such as being around intellectually esteemed peers and interaction with faculty were controlled.[4]

TABLE 2 ABOUT HERE

Women's/Coed Colleges Model. The purpose of this model is to test the hypothesis in question. The three global characteristics, women-only college status variable, enrollment size,

and mean pre-test, account for 92% of the total between-college variation (Table 3).

The hypothesis (i.e., women-only and coed colleges do not differentially affect intellectual self-confidence) was rejected by the women's/coed colleges model (p=0.004, Table 3). Controlling for both enrollment size and mean pretest scores on intellectual self-confidence among colleges, the effect of attending a women-only college on students' intellectual self-confidence was positive and significant (b=0.07, t=2.94).

When we consider the practical importance of this statistically significant finding, the difference in mean post-test intellectual self-confidence scores between women-only and coeducational colleges is not large, only 0.134 on a five-point scale.[5] In the student characteristics model (Table 2), the standard deviation for mean post-test scores is 0.18 on a five-point scale. Converting the estimate of 0.134 to standard deviation units (i.e., 0.134/0.18), the estimate of women-only colleges is equal to 0.74 standard deviations.

As expected, the mean pretest of intellectual self-confidence was a highly significant predictor ($p < 0.001$). Institutional selectivity had a significant and positive association with the college mean intellectual self-confidence post-test scores, but when the average pretest scores of intellectual self-confidence were included in the equation, selectivity became insignificant.[6] Thus, I removed selectivity and retained the mean pretest score of intellectual self-confidence in the model.

TABLE 3 ABOUT HERE

Full Model. The major purpose of the full model is to explore how the association between women-only colleges and college mean intellectual self-confidence post-test scores changes upon adding important internal characteristics of colleges. Only mean permissive peer orientation was significant (b=0.02, t=1.70) among the internal characteristics of colleges and

was added into the full model (Table 4). When the effect of mean permissive peer orientation was added to the equation, little change occurred in the estimation of the effect of women-only colleges (from b=0.067 to b=0.063) and in its statistical significance level (see Tables 3 and 4). Mean permissive peer orientation does not seem to be a good reason for the positive effect of women-only colleges on the development of intellectual self-confidence.

The four variables (women-only college status, enrollment size, mean pretest of intellectual self-confidence, and mean permissive peer orientation) account for 94% of the total between-college variation (Table 4). That is, 2% of the total college-level variation was improved by including mean permissive peer orientation in the equation. Testing the hypothesis that the amount of between-college variance that remains is 0, we observe a *p*-value of 0.129 (see the bottom of Table 4). This suggests that virtually no unexplained variance is left at the institution-level.

Institutional internal characteristics such as women's/minority studies, the offering of a progressive curriculum, the percent of expenditure on academic support, percent of expenditure on support services for students, mean of socially active and altruistic peer orientation, and student/faculty ratio were also considered. These variables, however, were not significantly associated with the college mean of women students' intellectual self-confidence at the end of their senior year.

TABLE 4 ABOUT HERE

Supplemental Model. The supplemental model is used (a) to explore the association between predictors of faculty climate and college mean post-test scores on intellectual self-confidence and (b) to observe change in the estimation of the effect of women-only colleges. Results obtained from use of the small data set were consistent with results from use of the large

data set. The pattern of significance among variables was also similar.

Interestingly, none of the institution-level variables capturing orientation among faculty were significant indicators of students' intellectual self-confidence, controlling for the same variables used in the full model with the large data set. It is important to note that the variable "percent of female faculty" was considered for inclusion in the supplemental model, but was eventually removed because it was *not* a significant predictor for the development of intellectual self-confidence among women students.

TABLE 5 ABOUT HERE

Critical Thinking and Problem-solving Skills

Student Characteristics Model. The student characteristics model includes two input variables and six environment variables as within-college predictors. Input variables are high school GPA and parental income, and the environment variables are association with intellectually esteemed peers, association with socially active and altruistic peers, leadership experience, interaction with faculty, participation in diversity awareness programs, and participation in an honors program (Table 6). The eight predictors contributed to a 6.5 % reduction in the amount of within-college variation.

Parental income had a significant positive effect on growth in critical thinking and problem-solving skills. Although high school GPA had an insignificant positive effect in the input-only equation, it was included because folk wisdom suggests that subsequent growth of critical thinking and problem-solving skills stem from academic preparation at college entry. However, it had a significant negative effect when the variable intellectually esteemed peer orientation was adjusted.

TABLE 6 ABOUT HERE

Women's/Coed Colleges Model. Three institution-level predictors (selectivity, black college, women-only college) were included along with the eight individual-level predictors (Table 7). In the women's/coed colleges model, 48.1% of the between-college variance was explained by the inclusion of these college-level predictors. It is important to note that the between-college variation in the college mean is very little to begin with (the standard deviation is only 0.11 in Table 6).

The hypothesis (i.e., women-only and coed institutions do not differentially affect development of critical thinking and problem-solving skills among women students) is not rejected (p=0.18). Although women-only college is a positive predictor for growth in critical thinking and problem-solving skills, the size of the b coefficient is small, only 0.027. When we consider practical importance, the difference in mean growth in critical thinking and problem-solving skills between women-only and coeducational colleges is only 0.054 on a five-point scale. This can be interpreted to mean that attending a women-only or a coeducational college does not matter to students' growth in critical thinking and problem-solving skills.

Interestingly, women-only colleges ceased to be a significant predictor once the black college indicator variable was added to the model. When black college status was controlled, the predictive power (b coefficient) of attending a women-only college dropped from 0.04 to 0.03; t dropped from 1.72 to 1.34, making the impact of women-only colleges insignificant.

Selectivity was strongly correlated with indicators of mean parental SES (parental income: r=0.51; father's level of education: r=0.57; and mean peer SES: r=76). Mean parental SES became insignificant when selectivity was added to the equation. This suggests not only that selectivity is an indication of students' level of academic preparation, but that it also reflects

institutional wealth, along with many other institutional characteristics.

TABLE 7 ABOUT HERE

Full Model. The women's/coed colleges model was expanded into the full model by adding two institution-level predictors: a progressive curriculum and women's/minority studies. Interestingly, a progressive curriculum has a significant negative effect on growth in critical thinking and problem-solving skills. "Progressive curriculum" was factor-loaded with six non-traditional course offerings (see Appendix B for the factor-loading items.) It is possible that a college with a curriculum oriented toward non-traditional subjects does not promote women students' growth in critical thinking and problem-solving skills.

Although not shown in Table 8, the predictive power of women-only college status slightly increased to b=0.032 (t=1.57) when "women's/minority studies" was removed from the model. This suggests that women-only colleges may detrimentally affect students' growth in critical thinking and problem-solving skills by offering such a non-traditional curriculum (r=0.05). On the other hand, when the positive predictor "women's/minority studies" was included to the model (Table 8), the predictive power of women-only colleges dropped slightly from b=0.032 (t=1.57) to b=0.026 (t=1.26). It seems that women-only colleges are more likely to emphasize women's/minority studies in their curriculum (r=0.14). Since women-only colleges were positively associated with both offering a progressive curriculum (negatively associated with the dependent variable) and placing emphasis on women's/minority studies (positively associated with the dependent variable), little change in the estimation of the effect of women-only colleges was observed between the women's/coed colleges model and the full model.

TABLE 8 ABOUT HERE

Supplemental Model. As shown in Table 9, the internal environment variables "faculty liberalism" and "faculty research orientation" were included in the supplemental model in addition to the predictors in the full model. When either faculty research orientation or faculty liberalism was adjusted in the equation, the predictivity of women-only colleges dropped sharply. The same holds true for selectivity and black colleges.[7]

The predictive power of women-only colleges dropped slightly (from b=0.027 to b=0.012) when faculty liberalism was included in the equation (not shown in Table 9). This suggests that a liberal climate among faculty in women-only colleges may help students to develop critical thinking and problem-solving skills. Women-only colleges seem to have a higher proportion of liberal faculty (r=0.19) than coeducational institutions.

An institutional climate oriented to faculty research is positively associated with students' growth in critical thinking and problem-solving skills. The predictive power of selectivity, however, dropped sharply (from b=0.060, t=3.24 to b=0.029, t=0.97) when faculty research orientation was adjusted. This reflects the reality that selective colleges tend to have a higher proportion of research-oriented faculty (r=0.76), and that selectivity and faculty research orientation share considerable predictive power.

TABLE 9 ABOUT HERE

Limitations and Future Studies

The primary limitation of this study is that questionnaire items were not designed specifically for this study, but were drawn from two national college student surveys and a national faculty survey. Most questionnaire items chosen call for self-rated or self-reported responses by college students and by faculty, although some institution-level variables, such as

selectivity (determined by average Scholastic Aptitude Test combined scores) were collected from each institution.

Students' self-reported perceptions of their development may not be equivalent to objective measures of development. However, "nearly all the evidence we have about student outcomes comes from students themselves--from their answers to achievement test items, personality test items, and questionnaires that we devise," while some researchers are inclined to dismiss students' opinions as biased (Pace 1985, p. 13).

No pre-test measures were available for the outcome of critical thinking and problem-solving skills. The lack of pre-test for this outcome had two limitations. First, it affected the amount of variance explained by the models. For the outcome of intellectual self-confidence, where pre-test data were available, the pre-test score helped to explain a high degree of variance in the within-college and the between-college models which leads to more power in trying to detect possible effects. Second, theoretically, using at least the two time points of college entry and exit is more valid for measurement of students' changes during the college years and measurement of college effectiveness than using only the post-tests of students' self-reported growth (e.g., in critical thinking and problem-solving skills) at point of exit.

Discussion and Conclusions

This study sought to assess the effectiveness of women-only and coeducational colleges by comparing their capacity to impact on two dimensions of intellectual development among women students: (1) intellectual self-confidence and (2) critical thinking and problem-solving skills.

Hypothesis 1 explores the question of whether type of college has a differential impact on the intellectual self-confidence of female students. Cross-tabulation and Wilcoxon tests showed

that a higher proportion of students in women-only colleges experienced an increase in their intellectual self-confidence during their college years. Also, a higher proportion of students in women-only colleges identified themselves to be in the "highest 10%" and " above average" categories of this variable on both the pre-test and the post-test. Through HLM analysis, the null hypothesis was rejected at p=0.004. Thus, attending women-only colleges is more beneficial to women students in developing self-rated intellectual self-confidence than attending coeducational institutions. This result is consistent with Astin's report (1993). It is also important to remember Kim and Alvarez's finding (1995) that women-only colleges have a positive impact on women students' social self-confidence. When we consider that intellectual self-confidence may be either a basis for or a result of intellectual development, it is important to find out why women students tend to develop their self-confidence more readily in women-only colleges. It can be assumed that this difference is not due to the faculty characteristics of either women-only colleges or coeducational institutions, judging from the fact that no faculty variable considered in the supplemental model was a significant predictor. Rather, an environment consisting only of women students may itself have unique characteristics that seem to help women students develop self-confidence.

Hypothesis 2, which examined whether type of college has a differential impact on growth in critical thinking and problem-solving skills of female students, was not rejected (p=0.18). Attending a women-only college was a positive predictor, but the estimated effect of women-only colleges was very small. Thus, I conclude that attending a women-only or a coeducational institution does not make a big difference with regard to self-reported growth in critical thinking and problem-solving skills. This result is partially inconsistent with Astin's reports (1977, 1993) that women-only colleges are more successful in developing critical

thinking ability in their students. One explanation for this inconsistency may be that Astin, among others, did not control for the effects of black colleges in the attempt to isolate the effect of women-only colleges. In this study, black college status was a significant positive predictor of self-perceived critical thinking and problem-solving skills. Moreover, the effect of women-only colleges sharply dropped to the point of insignificance when the effect of attending a black college was controlled.

Implications of Additional Findings

Although this study's major focus is on institution-level effects, it is important for educators and college academic program developers to pay attention to individual-level effects. Examination of within-college models may reveal what sorts of involvement by students are associated with their intellectual growth. Being around intellectually confident peers, interaction with faculty, and participation in diversity awareness programs were significant positive predictors for both intellectual self-confidence and critical thinking and problem-solving skills. In addition, students' involvement in leadership and other social activities seems to promote critical thinking and problem-solving skills. Educators and college curriculum developers would be well advised to a) develop campus diversity awareness programs as well as programs facilitating intellectual engagement among students and between students and faculty, and b) to encourage students' involvement in these activities.

At the institution level, faculty climate and curriculum emphasis seem to be directly influential factors. Faculty research orientation and faculty liberalism were positive predictors for development of critical thinking and problem-solving skills. A liberal climate probably encourages women students to engage in more intellectual activities and dialogues than a conservative one. Frequent interaction with liberal and research-oriented faculty should be

encouraged for the intellectual development of female college students. Recall that students' interaction with faculty at the individual level was a highly significant predictor for both outcomes. Having an emphasis on women's/minority studies within their curriculum also seems to explain some portion of the differential advantage of women-only colleges in promoting growth in critical thinking and problem-solving skills.

Interestingly, percent of female faculty in colleges was *not* a significant predictor for the two dimensions of intellectual development. This finding is contrary to Tidball's reports (1973, 1976, 1985, 1986) and is consistent with results reported by Kim and Alvarez (1995). This controversy suggests the need for more probing research regarding the effect of women faculty on various dimensions of development among women students. The importance of having a good role model from same-sex faculty should not be neglected in an examination of student development.

The equal presence of women and men in coeducational colleges was yesterday's dream. Today's dream must visualize more thoughtful institutional arrangements that take into account stages through which intellectual development of female students may progress and even flourish. These may be different within women-only and coeducational institutions yet have the same objectives: to maximize conditions under which students can fully develop their individual talents during their college years.

Notes

1 There were 2 black women's colleges and 8 black coeducational colleges among the 201 colleges in the large data set.

2 The total SD is based on the squared deviations of student scores from the grand mean. The total SD reflects both within-college variation and between-college variation.

$(\text{Total SD})^2 = (\text{Between-college SD})^2 + (\text{Within-college SD})^2$

3 According to the existing educational literature, academic preparation at point of entry and parental socioeconomic status should be controlled to assess students' intellectual development (Pascarella and Terenzini, 1991).

4 Throughout the process of building all the HLMs, I retained all input variables that were significant (i.e., those at the 0.10 alpha level) in the input-only equations, even if their coefficients dropped sharply due to a correlation with environment variables.

5 The difference between women-only and coeducational colleges becomes the double amount of the b coefficient because the variable, "women-only college," was effect-coded. (See Appendix A.)

6 Selectivity and the mean pretest scores of intellectual self-confidence have a moderate correlation (r=0.36).

7 As indicated earlier, the estimation of the effect of black colleges should be carefully interpreted, especially in the supplemental model which uses the small data set (only 4 black colleges of 86 colleges). The predictivity of black colleges also dropped and became insignificant when faculty liberalism was added to the equation (from b=0.105, to b=0.07, not shown in the table). This change suggests that black colleges and faculty liberalism (r=0.13) share predictivity for development of critical thinking and problem-solving skills.

Table 1

Changes During College in Women Students' Intellectual Self-confidence

(Coeducational colleges, N=2,101; Women-only colleges, N=391 in percentages)

	Coeducational		Women-only		Percent Change	
Self-Rating	1987	1991	1987	1991	Coed[a]	Women-only[b]
Highest 10%	10.9	16.2	16.6	24.0	5.3	7.4
Above average	43.2	48.6	38.1	47.8	5.4	9.7
Average	38.7	30.9	36.8	23.8	-7.8	-13.0
Below average	6.9	4.0	8.2	3.3	-2.9	-4.9
Lowest 10%	0.4	0.2	0.3	1.0	-0.2	0.7

Source: UCLA Higher education Research Institute, Cooperative Institutional Research Program. Follow-up-of 1987 freshmen survey conducted in summer of 1991.

[a] Wilcoxon test indicates significant change (-ranks: 354, +ranks: 714, ties: 1033); $p < .0001$ (two-tailed tests).

[b] Wilcoxon test indicates significant change (-ranks: 63, +ranks: 148, ties: 180); $p < .0001$ (two-tailed tests).

Table 2

Self-reported Development of Intellectual Self-confidence: Student Characteristics Model

(N=2,470 in 201 colleges)

Fixed Effect	*coefficients*	*se*	*t-ratio*	*p-value*
Between-college model				
Intercept, γ_{00}	3.760	0.023	165.936	0.000
Within-college model				
Input Characteristics				
Minority, γ_{10}	0.110	0.055	2.016	0.043
High School GPA, γ_{20}	-0.007	0.013	-0.539	0.590
Father's education, γ_{30}	0.010	0.008	1.190	0.235
Pretest: intellectual confidence, γ_{40}	0.215	0.026	8.222	0.000
Individual Environments/Experiences				
Peer: intellectual self-esteem, γ_{50}	0.057	0.007	8.193	0.000
Interaction with faculty, γ_{60}	0.175	0.050	3.522	0.001
In diversity programs, γ_{70}	0.139	0.059	2.341	0.019
In honors program, γ_{80}	0.110	0.032	3.413	0.001
Proportion of within-college variance explained	0.209			

	sd	*variance*	*df*	χ^2	*p-value*
Between-college variation	0.1825	0.0333	178	319.89	0.000
Within-college variation	0.6873	0.4723			

Table 3

Self-reported Development of Intellectual Self-confidence: Women's/Coed Colleges Model

(N=2,470 in 201 colleges)

Fixed Effect	*coefficients*	*se*	*t-ratio*	*p-value*
Between-college model				
Intercept, γ_{00}	2.064	0.171	12.048	0.000
Global College Environment				
Enrollment size,[a] γ_{01}	0.017	0.009	1.941	0.052
Mean pretest, γ_{02}	0.484	0.048	10.138	0.000
Women-only college, γ_{03}	0.067	0.023	2.941	0.004
Within-college model				
Individual Input Characteristics				
Minority, γ_{10}	0.110	0.054	2.020	0.043
High school GPA, γ_{20}	-0.007	0.013	-0.540	0.589
Father's education, γ_{30}	0.010	0.008	1.192	0.234
Pretest: intellectual confidence, γ_{40}	0.215	0.026	8.240	0.000
Individual Environment/Experiences				
Peer: intellectual self-esteem, γ_{50}	0.056	0.007	8.212	0.000
Interaction with faculty, γ_{60}	0.175	0.050	3.530	0.001
In diversity programs, γ_{70}	0.139	0.059	2.346	0.019
In honors program, γ_{80}	0.110	0.032	3.420	0.001
Proportion of between-college variance explained by global college characteristics	0. 917			

	sd	*variance*	*df*	χ^2	*p-value*
Between-college variation	0.0524	0.0028	175	198.44	0.108
Within-college variation	0.6857	0.4702			

[a] Enrollment size was divided by 1,000.

Table 4
Self-reported Development of Intellectual Self-confidence: Full Model
(N=2,470 in 201 colleges)

Fixed Effect	*coefficients*	*se*	*t-ratio*	*p-value*
Between-college model				
Intercept, γ_{00}	2.024	0.171	11.810	0.000
Global College Environment				
Enrollment size[a], γ_{01}	0.016	0.008	1.850	0.064
Mean pretest, γ_{02}	0.469	0.048	9.779	0.000
Women-only college, γ_{03}	0.063	0.022	2.818	0.005
Internal College Environment				
Mean peer: permissiveness, γ_{04}	0.021	0.012	1.696	0.090
Within-college model				
Individual Input Characteristics				
Minority, γ_{10}	0.110	0.054	2.020	0.043
High school GPA, γ_{20}	-0.007	0.013	-0.540	0.589
Father's education, γ_{30}	0.010	0.008	1.192	0.234
Pretest: intellectual confidence, γ_{40}	0.215	0.026	8.239	0.000
Individual Environment/Experiences				
Peer: intellectual self-esteem, γ_{50}	0.056	0.007	8.210	0.000
Interaction with faculty, γ_{60}	0.175	0.050	3.529	0.001
In diversity programs, γ_{70}	0.139	0.059	2.346	0.019
In honors program, γ_{80}	0.110	0.032	3.420	0.001
Proportion of between-college variance explained by all college variables	0. 937			

	sd	*variance*	*df*	χ^2	*p-value*
Between-college variation	0.0458	0.0021	174	195.27	0.129
Within-college variation	0.6858	0.4704			

[a] The number corresponding to enrollment size was divided by 1,000.

Table 5

Self-Reported Development of Intellectual Self-confidence: Supplemental Model

(N=1,395 in 86 colleges)

Fixed Effect	*Coefficients*	*se*	*t-ratio*	*p-value*
Between-college model				
Intercept, γ_{00}	1.924	0.240	8.012	0.000
Global College Environment				
Enrollment size,[a] γ_{01}	0.027	0.012	2.272	0.023
Mean pretest, γ_{02}	0.481	0.069	6.996	0.000
Women-only college, γ_{03}	0.061	0.025	2.452	0.014
Internal College Environment				
Mean peer: permissiveness, γ_{04}	0.028	0.016	1.735	0.082
Within-college model				
Individual Input Characteristics				
Minority, γ_{10}	0.091	0.068	1.323	0.186
High school GPA, γ_{20}	-0.018	0.017	-1.058	0.291
Father's education, γ_{30}	0.010	0.011	0.888	0.375
Pretest: intellectual confidence, γ_{40}	0.221	0.035	6.229	0.000
Individual Environment/Experiences				
Peer: intellectual self-esteem, γ_{50}	0.049	0.009	5.287	0.000
Interaction with faculty, γ_{60}	0.181	0.065	2.771	0.006
In diversity programs, γ_{70}	0.127	0.077	1.640	0.101
In honors program, γ_{80}	0.159	0.042	3.797	0.000

	sd	*variance*	*df*	χ^2	*p-value*
Between-college variation	0.0315	0.0010	72	66.296	0.500
Within-college variation	0.6929	0.4801			

Note. No faculty orientation characteristic was significant.

[a] The number corresponding to enrollment size was divided by 1,000.

Table 6

Growth in Critical thinking and Problem-solving Skills: Student Characteristics Model

(N=2,470 in 201 colleges)

Fixed Effect	*coefficients*	*se*	*t-ratio*	*p-value*
Between-college model				
Intercept, γ_{00}	4.276	0.015	277.115	0.000
Within-college model				
Input Characteristics				
High school GPA, γ_{10}	-0.028	0.009	-2.936	0.004
Parental income, γ_{20}	0.007	0.004	1.989	0.046
Individual Environment/Experiences				
Peer: intellectual self-confidence, γ_{30}	0.021	0.004	5.600	0.000
Peer: social activism, γ_{40}	0.017	0.004	4.278	0.000
Leadership experience, γ_{50}	0.056	0.029	1.908	0.056
Interaction with faculty, γ_{60}	0.183	0.037	4.959	0.000
In diversity programs, γ_{70}	0.098	0.044	2.233	0.025
In honors programs, γ_{80}	0.059	0.023	2.543	0.011
Proportion of within-college variance explained	0.065			

	sd	*variance*	*df*	χ^2	*p-value*
Between-college variation	0.1137	0.0129	190	306.54	0.000
Within-college variation	0.4997	0.2497			

Table 7
Growth in Critical Thinking and Problem-solving Skills: Women's/Coed Colleges Model
(N=2,470 in 201 colleges)

Fixed Effect	*coefficients*	*se*	*t-ratio*	*p-value*
Between-college model				
Intercept, γ_{00}	3.883	0.105	36.899	0.000
Global College Environment				
Selectivity [a], γ_{01}	0.051	0.011	4.601	0.000
Black college, γ_{02}	0.097	0.042	2.326	0.020
Women-only colleges, γ_{03}	0.027	0.020	1.340	0.180
Within-college model				
Individual Input Characteristics				
High school GPA, γ_{10}	-0.028	0.009	-2.930	0.004
Parental income, γ_{20}	0.007	0.004	1.984	0.047
Individual Environment/Experiences				
Peer: intellectual self-esteem, γ_{30}	0.021	0.004	5.588	0.000
Peer: social activism, γ_{40}	0.017	0.004	4.269	0.000
Leadership experience, γ_{50}	0.057	0.029	1.904	0.056
Interaction with faculty, γ_{60}	0.183	0.037	4.949	0.000
In diversity programs, γ_{70}	0.098	0.044	2.228	0.026
In honors programs, γ_{80}	0.059	0.023	2.537	0.011
Proportion of variance explained by global college characteristics	0.481			

	sd	*variance*	*df*	χ^2	*p-value*
Between-college variation	0.0817	0.0067	187	256.30	0.001
Within-college variation	0.5008	0.2508			

[a] Selectivity was divided by 100.

Table 8
Growth in Critical Thinking and Problem-solving Skills: Full Model
(N=2,470 in 201 colleges)

Fixed Effect	*coefficients*	*se*	*t-ratio*	*p-value*
Between-college model				
Intercept, γ_{00}	3.888	0.107	36.360	0.000
Global College Environment				
Selectivity [a], γ_{01}	0.055	0.013	4.103	0.000
Black college, γ_{02}	0.097	0.042	2.296	0.022
Women-only colleges, γ_{03}	0.026	0.021	1.263	0.207
Internal College Environment				
Progressive curriculum, γ_{04}	-0.059	0.024	-2.482	0.013
Women's/minority studies, γ_{05}	0.075	0.043	1.738	0.082
Within-college model				
Individual Input Characteristics				
High school GPA, γ_{10}	-0.028	0.009	-2.933	0.004
Parental Income, γ_{20}	0.007	0.004	1.987	0.047
Individual Environment/Experiences				
Peer: intellectual self-esteem, γ_{30}	0.021	0.004	5.595	0.000
Peer: social activism, γ_{40}	0.017	0.004	4.274	0.000
Leadership experience, γ_{50}	0.056	0.029	1.906	0.056
Interaction with faculty, γ_{60}	0.183	0.037	4.950	0.000
In diversity programs, γ_{70}	0.098	0.044	2.231	0.026
In honors programs, γ_{80}	0.059	0.023	2.540	0.011
Proportion of between-college variance explained by all college variables	0.465			

	sd	*variance*	*df*	χ^2	*p-value*
Between-college variation	0.0830	0.0069	186	254.74	0.001
Within-college variation	0.5002	0.2502			

[a] The number associated with selectivity was divided by 100.

Table 9
Growth in Critical Thinking and Problem-solving Skills: Supplemental Model
(N=1,394 in 86 colleges)

Fixed Effect	*coefficients*	*se*	*t-ratio*	*p-value*
Between-college model				
Intercept, γ_{00}	3.051	0.357	8.549	0.000
Global College Environment				
Selectivity, γ_{01}	0.028	0.029	0.968	0.333
Black college, γ_{02}	0.034	0.067	0.507	0.612
Women-only colleges, γ_{03}	0.017	0.028	0.624	0.533
Internal College Environment				
Progressive curriculum, γ_{04}	-0.065	0.037	-1.784	0.074
Women's/minority studies, γ_{05}	0.018	0.063	0.286	0.774
Faculty research orientation, γ_{06}	0.017	0.011	1.584	0.113
Faculty liberalism, γ_{07}	0.039	0.020	1.958	0.050
Within-college model				
Individual Input Characteristics				
High school GPA, γ_{10}	-0.036	0.013	-2.863	0.005
Parental income, γ_{20}	0.007	0.005	1.334	0.182
Individual Environment/Experience				
Peer: intellectual esteem, γ_{30}	0.018	0.005	3.562	0.001
Peer: social activism, γ_{40}	0.017	0.005	3.133	0.002
Leadership experience, γ_{50}	0.054	0.039	1.382	0.167
Interaction with faculty, γ_{60}	0.232	0.049	4.769	0.000
In diversity programs, γ_{70}	0.112	0.058	1.935	0.053
In honors programs, γ_{80}	0.055	0.031	1.813	0.069

	sd	*variance*	*df*	χ^2	*p-value*
Between-college variation	0.0917	0.0084	76	112.60	0.004
Within-college variation	0.5082	0.2583			

[a] The number associated with selectivity was divided by 100.

Appendix A
Variables and Coding Scheme for Study of Intellectual Development

INPUT

Within-college variables
(*individual-level*)

Pretests	
Intellectual self-confidence	Five-point scale from 1=lowest 10% to 5=highest 10%.
Degree aspiration	Ph.D., M.D.,D.D.S., D.V.M., LL.B., J.D. Doctor of Divinity=2, Bachelors, Masters degree= 1.
High school GPA	Eight-point scale from1=D to 8=A or A+.
Parental income	Fourteen-point scale: 1=less than $6,000 to 14=$150,000 or more.
Father's education	Eight-point scale: 1=grammar school or less, to 8=graduate degree.
Minority	Dummy coded: 1=white, 2=minority (nonwhite).

COLLEGE ENVIRONMENT

Between-college variables
(*institution-level*)

Global Characteristics	
Women-only colleges	Effect coded: -1=coeducational colleges, 1=women-only colleges.
Catholic colleges	Effect coded: -1=non-Catholic colleges, 1=Catholic colleges.
Black colleges	Effect coded: -1 = White colleges, 1=historically Black colleges.
East (location on the East coast)	Effect coded: -1= institutional region not in the East, 1=institutional region in the east.
Enrollment Size	Continuous scale
Selectivity	Institutional selectivity based on SAT combined scores, ranges from 400 to 1600.
Internal Characteristics	
Mean peer permissiveness	All aggregated peer factor scores
Mean peer social activism	(see Appendix B for combined items.)
Women's/minority studies	Four-point scale from 1=none to 4=major status.
Progressive curriculum offerings	
Expenditure	Continuous scale.
A. Academic expenditures Academic support (including research and library)	
B. Student services expenditures	
Average faculty salary	Continuous scale.
Faculty liberalism	Continuous scale.
Faculty research orientation	
Faculty diversity orientation	
Faculty social and community activism	
Faculty student orientation	

Percent of female faculty
Student-faculty interaction

Within-college variables
(*individual-level*)

Peer orientation — Individual peer factor scores; for detailed information see Astin (1993).

Peer intellectual-self esteem
Peer permissiveness
Peer social activism
Peer socioeconomic status

Activities during college — From A to F, two-point scale answer: 1=not marked, 2=marked

A. Leadership experience
--Actively involved in student organizations
--Elected to student office
--Participated in leadership classes/programs
B. Campus work experience
--Had part-time job on campus
--Participation in college internship program
C. Interaction with faculty
--Worked on professor's research project
--Faculty took personal interest in my progress
D. Participation in diversity awareness programs
--Attended racial/cultural awareness workshops
--Enrolled in women's studies courses
--Enrolled in ethnic studies courses
--Participated in study abroad programs
E. Participation in campus protests/demonstrations
F. Enrolled in honors programs

OUTCOME

(*Within-college variables*)

Intellectual self-confidence — Five-point scale answer from 1=lowest 10% to 5=highest 10% (pretest available).

Critical thinking and problem-solving skills — Five-point scale answer from 1=much weaker to 5=much stronger.

--Ability to think critically
--Analytical and problem-solving skills

Appendix B
Items constituting Factor Scales

Peer Orientations [a]

Peer intellectual self-esteem	
Academic ability (self-rating)	.93
Public-speaking ability (self-rating)	.91
Drive to achieve (self-rating)	.91
Leadership ability (self-rating)	.90
Intellectual self-confidence (self-rating)	.90
Writing ability (self-rating)	.87
Mathematical ability (self-rating)	.80
Election to an academic honor society (expectation)	.87
Peer permissiveness	
A couple should live together for some time before deciding to get married (attitude).	.94
If two people really like each other, it's all right for them to have sex. even if they've been known each other for only a very short time (attitude).	.87
Marijuana should be legalized(attitude).	.86
Attended a religious service (behavior).	-.86
Divorce laws should be liberalized (attitude).	.80
Abortion should be legalized (attitude).	.75
Peer social activism and altruism	
Participating in a community action program (life goal)	.87
Promoting racial understanding (life goal)	.85
Influencing social values (life goal)	.75
Helping others who are in difficulty (life goal)	.70
Becoming involved in programs to clean up the environment (life goal)	.65

Curriculum Orientations [b]

Progressive curriculum	
Women's studies likely to be offered as a major	.69
Ethnic studies likely to be offered as a major	.68
Students may elect to pursue an independent major	.45
Religious courses required of students	-.43
Students may elect to pursue a combined major	.43
Number of humanities courses required of students	-.40

Faculty Orientations [a]

Social activism and community orientation	
Institutional goal: Teach students how to change society.	.73
Institutional goal: Develop leadership ability among students.	.66
Institutional goal: Help solve major social and environmental problems.	.65
Institutional goal: Develop a sense of community among faculty and students.	.62
Institutional goal: Help students understand their own values.	.62
Institutional goal: Facilitate involvement in community service activities.	.58

Student orientation of the faculty	
Faculty here are interested in students' academic problems.	.65
Faculty here are interested in students' personal problems.	.62
Faculty here are committed to the welfare of the institution.	.53
Many faculty are sensitive to the issues of minorities.	.47
Faculty are easy to see outside of office hours.	.46
Students are treated like numbers in a book.	-.44
There are many opportunities for student-faculty interaction.	.40
Research orientation	
How many articles have you published in academic or professional journals?	.72
How many of your professional writings have been published or accepted for publication in the last two years?	.72
Do your interests lie primarily in teaching or research [scored for research]?	.71
How important for you (as a personal or professional goal) is engaging in research?	.68
How many hours per week do you spend on research and scholarly writing?	.66
How many chapters have you had published in edited volumes?	.59
How important to you personally is it to become an authority in your field?	.53
Have you received intra- or extra-mural funds for research?	.52
How many days during the past academic year were you away from campus for professional activities (such as professional meetings, speeches, or consulting)?	.47
How important to you personally is it to obtain recognition from colleagues for contributions to your special field?	.46
Liberalism	
Political self-label: liberal or far left (versus conservative or far right).	.73
Belief: A national health care plan is needed to cover every body's health costs.	.61
Belief: Wealthy people should pay a larger share of taxes than they do now.	.54
Belief: Abortion should be legal.	.41
Belief: Colleges should be actively involved in solving social problems.	.40

[a] See Astin(1993) for a more detailed description.
[b] See Hurtado, Astin, and Dey, 1991 for more information.

Appendix C

The Equations of the Hierarchical Linear Models to Study College Effectiveness in Intellectual Development

Within-college model:

$$Y_{ij} = \beta_{0j} + \beta_{1j}(X_{1ij} - \overline{X_{1j}}) + \beta_{2j}(X_{2ij} - \overline{X_{2j}}) + \ \ldots \ + \beta_{pj}(X_{pij} - \overline{X_{pj}}) + r_{ij}.$$

$$r_{ij} \sim N(0, \sigma^2).$$

Between-college model:

$$\beta_{0j} = \gamma_{00} + \gamma_{01} W_{1j} + \gamma_{02} W_{2j} + \ \ldots \ + \gamma_{0k} W_{kj} + u_{0j}. \qquad u_{0j} \sim N(0, \tau_{00}).$$

$$\beta_{1j} = \gamma_{10}$$

$$\beta_{2j} = \gamma_{20}$$

$$\vdots$$

$$\vdots$$

$$\beta_{pj} = \gamma_{p0}$$

where Y_{ij} is the response of student *i* in college *j*,

β_{0j} is the mean score for college *j*,

β_{pj} is the slope of college *j* for the *p*th individual student level predictor,

X_{pij} is student *i* in college *j* for the *p*th individual student level predictor,

$\overline{X_{pj}}$ is the mean score of students in college *j* for the *p*th individual student level predictor,

r_{ij} is a random error (within-college residuals assumed mean 0 and normally distributed with variance σ^2),

σ^2 is a measure of within-college variation,

γ_{00} is the grand mean for the outcome of interest,

$\gamma_{0k} W_{kj}$ is the mean score of college *j* for the *k*th college level predictor,

γ_{p0} is the college level coefficient that captures the common effect, of the *p*th individual student level predictor on the outcome of interest,

u_{0j} is a random error (between-college residuals that capture the deviation of the mean for college *j* assumed mean 0 and normally distributed with variance τ_{00}), and

τ_{00} is a measure of between-college variation.

Note. In the analysis of the present study there tends to be little variation in college slopes and so they were treated as non-varying.

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